Selective Spinal Fusion for Lenke Type 5C Adolescent Idiopathic Scoliosis: Short Term Radiographic Follow Up.

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ABSTRACT

Objective: To determine the short term radiological outcomes of Lenke type 5C adolescent idiopathic scoliosis in terms of Cobb angle correction and coronal balance after selective posterior segmental spinal instrumentation with pedicle screws.

Methods: This retrospective cohort study was conducted in Department of Orthopedic and Spine Surgery Ghurki Trust Teaching Hospital/ Lahore Medical and Dental College Lahore. The medical records of patients from 17th April 2015 to 29th October 2019 who underwent selective spinal fusion with pedicle screws for Lenke type 5C adolescent idiopathic scoliosis were reviewed. Pre operative radiographs were evaluated for Cobb angle of lumbar or thoracolumbar curve as well as sagittal and lumbar modifier on anteroposterior and lateral standing films. The curve correction, implant density, number of segment fused and coronal balance was assessed on post operative radiographs. The pre and post operative comparison of important study variables were done and *P* value was calculated with the help of Chi-square test. *P* value < 0.05 was considered statistically significant.

Results: The total number of patients were 34. Majority (94.1%,n=32) were females while only 2(5.9%) were males. The mean age at the time of operation was 14.35±2.19 years (range 8 to 19 years). Mean pre-operative and post-operative Cobb angles were 61.79^0±13.12^0 (range 40^0 to 85^0) and 10.55^0±8.71^0 (range 0^0 to 30^0) respectively (*P* value 0.00). The mean percentage of curve correction and percentage of fulcrum flexibility was 83.35±13.07 % (range 55% to 100%) and 59.56%±15.07 (range 28.57% to 84.60%) respectively (*P* value 0.469). Mean implant density and fusion mass was 66.03±7.94% (range 53 to 79%) and 10.32±2.8 (range 7 to 15%) segments respectively. The coronal balance was achieved in all patients. No major complication was noted.

Conclusion: Near normal Cobb angle correction and coronal balance was achieved in all patients of Lenke type 5C adolescent idiopathic scoliosis treated with posterior segmental spinal instrumentation utilizing pedicle screws.

Keywords: Adolescent Idiopathic Scoliosis, Cobb angle, Lenke type 5C, Pedicle, Spine.

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INTRODUCTION

Idiopathic scoliosis is lateral deviation of the spine in excess of 10 degrees with no definite aetiology unlike congenital, neuromuscular and syndromic types.[1] Adolescent idiopathic scoliosis (AIS) accounts for about 85% of idiopathic scoliosis.[2] Lenke type 5C is characterized by a single major structural curve in thoracolumbar or lumbar spine accompanied by two non-structural minor curves. [3] It has been reported that more than 50% of patients with Lenke type 5 AIS with curve of more than 40 degrees showed progression after the age of 20 years.[4] Therefore

surgery is indicated for progressive curve of more than 40^0 in Lenke 5 AIS.[5] Both clinically and radiologically Lenke 5C AIS is associated with global coronal imbalance.[4,5] Selection of appropriate proximal and distal level of fusion has a direct impact on radiological outcomes in terms of curve correction and coronal balance.[6]

Various treatment options for AIS are exercise, brace and surgery.[7] Surgical options for Lenke 5 AIS are divided into anterior and posterior corrections utilizing different approaches.[8] With single rod-screw system through anterior approach excellent curve correction can be achieved with short fusion mass. [9] However disadvantages associated with anterior approach are poor derotation, junctional kyphosis and implant breakage.[10] Due to excellent pull-out strength of the pedicle screws, posterior approach provide excellent curve correction as well as better derotation.[11]

The objective of our study was to determine short term radiological outcomes of Lenke type 5C adolescent idiopathic scoliosis in terms of Cobb angle correction and coronal balance after selective posterior segmental spinal instrumentation with pedicle screws.

METHODS

We conducted this retrospective cohort study in Department of Orthopedic and Spine Surgery Ghurki Trust Teaching Hospital/ Lahore Medical and Dental College Lahore. The medical records of all patients who were operated in the time period extending from 17th April 2015 to 29th October 2019 for selective spinal fusion with pedicle screws for Lenke type 5C adolescent idiopathic scoliosis were reviewed. Patients of either gender and all ages with Lenke type 5C AIS with complete record of minimum of one year follow up were included in our study. All patients with congenital or neurological scoliosis and those having past history of spinal surgery, trauma and infections were excluded. The study protocols were approved by the Ethical Committee of our hospital. Radiological evaluation included calculation of the pre-operative and post-operative Cobb angle on standing posteroanterior (PA) radiographs, implant density, coronal balance, sagittal and lumbar modifier on standing posteroanterior and lateral views and fulcrum views. Curve flexibility was assessed by fulcrum bending radiographs which were taken by placing patient in lateral decubitus position over appropriate padded cyclinder.[12]Coronal balance was measured in millimeters from C7 plumb line and central sacral vertical line (CSVL) on postoperative standing posteroanterior radiographs. A value >20millimeters was taken as imbalance.

Following equations were used for documentation and interpretation of our results:

- Correction rate Percentage: Preoperative Cobb angle-Postoperative Cobb angle×100/preoperative Cobb angle
- Fulcrum flexibility percentage: Preoperative Cobb angle- Cobb angle on fulcrum films/ pre-operative Cobb angle
- Implant density: Number of screws/Number of segment fused

SSPSS version 21.0 was used for statistical analysis. Mean and standard deviation was calculated for age, preoperative Cobb angle, postoperative Cobb angle, fulcrum flexibility percentage, correction rate and implant cost. Chi-square test was applied for calculating *P* value of important study variables after comparison. *P* value of < 0.05 was considered for statistical significance. We reported our Cohort study in accordance with STROBE guidelines.[13]

Operative Procedure

The medical record revealed that all operations were done by single spinal deformity correction surgeon using identical technique. The operative notes indicated that all procedures were done in prone position on radiolucent table under controlled hypotensive anesthesia. Somatosensory evoked potential and motor evoked potential (Intraoperative neuro monitoring) was used during the procedure. Midline incision was given over the spinous processes and subperiosteal dissection was done to expose the pedicles and transverse processes. All pedicle screws were passed by free hand technique and confirmed by intraoperative imaging. Poly Nices Spine System (Kanghui Medical Innovation, Medtronics subsidiary, China) was use for instrumentation. Two levels each at upper and lower end of fusion mass were instrumented bilaterally followed by instrumentation of one vertebrae at apex on convex side and two adjacent vertebrae on concave side. Facet joints and spinouts process was excised to provide raw area as well as autogenous bone graft for spinal fusion. Upper end vertebrae (UEV) were neutral and lower end vertebrae (LEV) were stable. However final decision was dependent on intraoperative alignment of disc below LEV. If a level disc was achieved instrumentation was stopped at LEV otherwise instrumentation was extended to one level below. Pre-contoured rob was placed to correct the coronal and sagittal balance. Residual deformity was

corrected by distracting the concave side and compressing the convex side of deformity. Rotational deformity was corrected by rod derotation method. (Fig I, II, III, IV)Single drain was place in sub fascial area which was removed on first postoperative day and patient was mobilized.

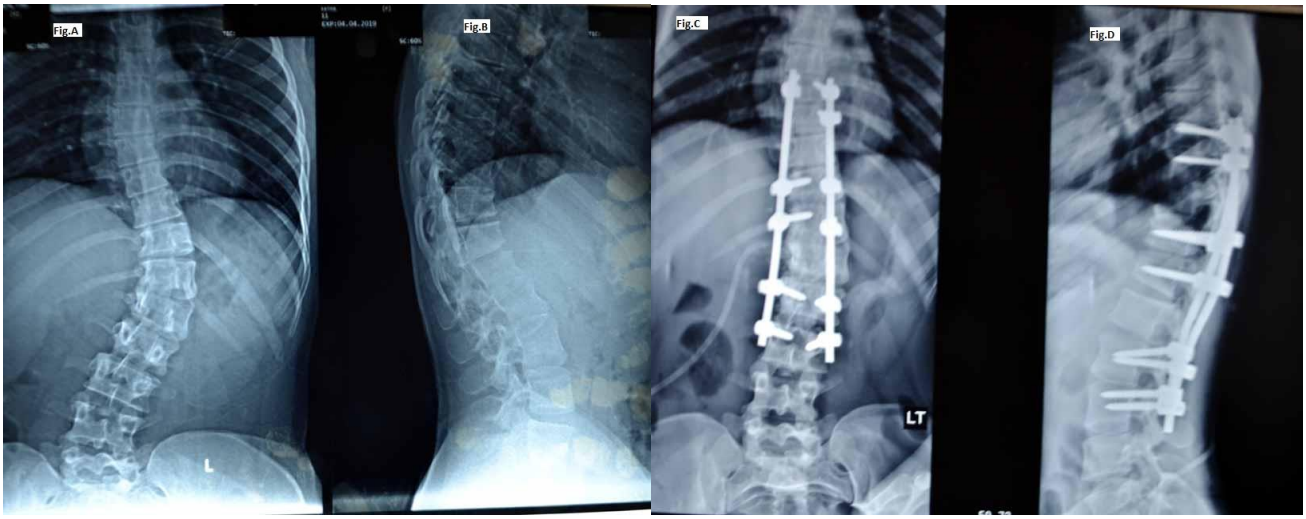

Fig. I and II: Preoperative standing PA and Lateral radiographs of a 17 years old girls showing Lenke type 5C AIS curve.
Fig. III and IV: PA and Lateral radiographs of the same patient showing curve correction by selective spinal instrumentation with pedicle screws and rods.

RESULTS

Total patients included in our study were 34. There were 32(94.1%) females and 2(5.9%) male patients. The mean age at the time of operation was 14.35±2.19 years (range 8 to 19 years). The mean follow up duration was 35.58±16.33 months (range 12 to 40 months).Medical records revealed that mean pre-operative and post-operative curve angles were 61.79^0±13.12^0 (range 40^0 to 85^0) and 10.55^0±8.71^0 (range 0^0 to 30^0) respectively (*P* value 0.00). The mean percentage of curve correction and percentage of fulcrum flexibility was 83.35±13.07 % (range 55% to 100%) and 59.56%±15.07 (range 28.57% to 84.60%) respectively. Mean implant density and fusion mass was 66.03±7.94% (range 53 to 79%) and 10.32±2.8 (range 7 to 15%) segments respectively. The mean Cobb angle of fulcrum view was 25.35^0±12.32^0(range 10^0 to 50^0)

According to the sagittal modifier majority(50%,n=17) of patients had normal kyphotic balance followed by hypo kyphotic sagittal balance in 13(38.2%) and hyper kyphotic in 4(11.8%) patients. The The coronal balance was achieved in all patients. Our patients had mean hospital stay of 5.71±1.59 days(range 3 to 8 days). The mean implant cost was 85082.3± 16564.44 rupees. There was no neurological complications or screw misplacement postoperatively.

DISCUSSION

This retrospective Cohort of 34 patients with Lenke type 5C treated by selective posterior segmental spinal fusion showed that excellent coronal correction and balance can be achieved with limited number of pedicle screws thus minimizing cost and time of procedure as well as pedicle screw related complications. The primary goal of surgical treatment of scoliosis is to achieve coronal and sagittal alignment as well as correcting the deformity and saving motion segments.[14] There is strong relationship between postoperative coronal balance and preoperative and postoperative lower instrumented vertebrae.[15]

Preoperative and postoperative Cobb angle in our series was 61.79^0±13.12^0 (range 40^0 to 85^0) and 10.56^0±8.71^0 (range 0^0 to 30^0) respectively. The postoperative correction rate was 83.35± 13.07% (range 55 to 100%) and the coronal balance was achieved in all patients. Our results are comparable with other studies reported in literature. Shetty and his colleague[16] in their 23 consecutive Lenke type 5C patients had mean preoperative and postoperative Cobb angle of 55.01^0 ±13.26^0 and 15.19^0 ±8.91^0 respectively. They achieved correction rate in 72.3%, coronal balance in 19(82.6%) and coronal imbalance in 4(17.3%) patients. O'Donnel and Michael[17] in their comparative analysis of radiological and clinical outcomes of posterior versus anterior fusion of Lenke

type 5 scoliosis observed that posterior spinal fusion(PSF) had shorter operative time than anterior spinal fusion(ASF). However length of fusion, blood loss and hospital stay was higher in posterior than anterior fusion surgery. Preoperative Cobb angle was larger in PSF than ASF group. Postoperative curve correction in PSF versus ASF was 66% and 62% respectively.

Liu Z *et al* [18] in their series of 42 patients had noted that correction rate was 75.6±8.5% and the Cobb angle improved from pre operative mean $46.8^0 \pm 4.8^0$ to mean $13.3^0 \pm 2.6^0$ post operatively.

Mean implant density in our study was 66.03±7.94% (range 53 to 79%) screws per fused segments. The Cobb angle correction was not found to be related to the number of screws per segment. Chen J *et al*[19] in retrospective review of 39 patients noted positive correlation between implant density and curve correction. Sariylimaz and Ozkunt[20] in their comparative study and Tannous *et al*[21] in their retrospective study documented that curve correction in high versus low implant density had no significant correlation between Cobb angle correction and implant density.

Our study had few limitation such as small number of patients and retrospective nature of our study design. Moreover we did not evaluate patient reported outcomes, procedure time, blood loss and relationship between upper and lower instrumented vertebrae and coronal balance. We therefore, suggest further studies to address all these limitations and verify our results.

CONCLUSION

Near normal Cobb angle correction and coronal balance was achieved in all patients of Lenke type 5C adolescent idiopathic scoliosis treated with posterior segmental spinal instrumentation utilizing pedicle screws. High flexibility of Lenke type 5 AIS curve makes it unique from other curves. As a result, excellent correction of curve and coronal balance can be achieved with limited numbers of anchors thus minimizing cost, procedure time and blood loss.

Conflict of Interest: None

Grants/Funding: None

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